Beckman Industrial™

CIRCUITMATE™ DIGITAL MULTIMETERS OPERATOR'S MANUAL for the MODELS DM15, DM20, and DM25

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INSTRUMENTATION PRODUCTS DIVISON
BECKMAN INDUSTRIAL CORPORATION
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Section One
INTRODUCTION

The CircuitMate™ Models DM15, DM20, and DM25 are completely portable 3½-digit multimeters designed for use by technicians, servicemen, students, and hobbyists who require an instrument that is accurate, reliable, and always ready for use. Equipped with six to nine functions and twenty-five to thirty-two ranges, these instruments provide full capability and convenient use, with a single selector switch and tilt bail.

These multimeters include all of the following features as standards:

1. 3½-Digit LCD
2. Overload Protection
3. DC Volts — Five Ranges
4. AC Volts — Five Ranges
5. DC Amps — Five Ranges (Model DM20)
6. AC Amps — Five Ranges (Model DM20)
7. Resistance — Six Ranges
8. Diode Check
9. 10 Amps AC and DC
10. Continuity Beeper (Model DM25)
11. Conductance (Models DM20 and DM25)
12. HFE Test (Model DM20)
13. Capacitance (Model DM25)
14. Low Battery Voltage Indicator
15. Single Function and Range Selector Switch

NOTE

The symbol ⚠ on the front panel of the instrument is an international symbol meaning "REFER TO OPERATION INSTRUCTIONS." Warnings and safety precautions to avoid personal injury and instrument damage are listed in Section 5.

Section Two
SPECIFICATIONS

Specifications are subject to change without notice.

2.1 GENERAL SPECIFICATIONS

Display :	3½-digit liquid crystal display (LCD) with a maximum reading of 1999
Polarity :	Automatic, (–) negative polarity indication
Zero adjustment :	Automatic
Overrange indication :	Highest digit of (1) or (–1) is displayed
Low battery indication :	The (LO BAT) is displayed when the battery voltage drops below the operating voltage
Measurement rate :	Three measurements per second, nominal
Operating temperature :	0°C to +50°C, 0-70% RH
Storage temperature :	–20°C to +60°C, 0-80% RH with battery removed
Accuracy :	Accuracy specifications at 23°C ±5°C, less than 70% RH
Power :	Single standard 9-volt battery; NEDA 1604, JIS 006P, IEC 6F22
Battery life: (Typical)	1) Heavy-duty zinc chloride battery: DM15 and DM20, 200 hours DM25, 70 hours 2) Carbon-zinc battery: DM15 and DM20, 150 hours DM25, 50 hours

Dimensions:	5.9 inches (15 cm) long, 3.23 inches (8.2 cm) wide, 0.97 inches (2.5 cm) high
Weight:	5.75 ounces (0.22 kg), including battery
Accessories:	Test leads (pair), spare fuse (0.8A), battery, operator's manual, vinyl case

2.2 ELECTRICAL SPECIFICATIONS

Accuracies are ± (% reading plus number of digits) at 23°C±5°C, less than 70% RH.

	MODEL DM15	MODEL DM20	MODEL DM25
DIGITS	3½	3½	3½
FUNCTIONS	DC volts AC volts DC amps AC amps Resistance Diode test	DC volts AC volts DC amps AC amps Resistance Diode test HFE test Conductance	DC volts AC volts DC amps AC amps Resistance Diode test Conductance Continuity (beeper) Capacitance
DC VOLTS			
Ranges	5 (0.2V to 1000V)	5 (0.2V to 1000V)	5 (0.2V to 1000V)
Accuracy	0.8% of reading + 1 digit	0.8% of reading + 1 digit	0.8% of reading + 1 digit
Input impedance	10MΩ	10MΩ	10 MΩ
Overload protection			
0.2V range	500 VDC(15 sec) 350 VAC(15 sec)	500 VDC (15 sec) 350 VAC (15 sec)	500 VDC (15 sec) 350 VAC (15 sec)
All other ranges	1200VDC 800 VAC	1200 VDC 800 VAC	1200 VDC 800 VAC
Resolution	100μV	100μA	100μA ( )
AC VOLTS			
Ranges	5(0.2V to 750V)	5 (0.2V to 750V)	5 (0.2V to 750V)
Accuracy (all ranges except 750V)	1.2% of reading +10 digits, 50 Hz to 500Hz	1.2% of reading + 10 digits, 50 Hz to 500 Hz	1.2% of reading + 10 digits, 50 Hz to 500Hz
750V)	50 Hz to 400Hz	50 Hz to 400 Hz	50 Hz to 400Hz
Input impedance	10MΩ	10MΩ	10MΩ
Overload protection	1200 VDC 850 VAC	1200VDC 850 VAC	1200VDC 850 VAC
200 mV range	500 VDC(15 sec) 350 VAC(15 sec)	500 VDC (15 sec) 350 VAC -(15 sec)	500VDC (15 sec) 350VAC (15 sec)
Resolution	100μV	100μV	100μV
DC CURRENT			
Ranges	4(200μA to 10A)	5 (200μA to 10A)	4(200μA to 10A)
Accuracy			
200μA to 20mA or 200mA range	1.25% of reading + 1 digit	1.25% of reading + 1 digit	1.25% of reading + 1 digit
10A range	3.0% of reading + 3 digits	2.0% of reading + 3 digits	2.0% of reading + 3 digits

SPECIFICATIONS (Continued)

	MODEL DM15	MODEL DM20	MODEL DM25
DC CURRENT (Cont.)			
Overload Protection	0.8A/250V fuse	0.8A/250V fuse	0.8/250V fuse
10A range	Unfused	Unfused	Unfused
Voltage Burden	325mV	325mV	325mV
10A range only	700mV	700mV	700mV
Resolution	100nA	100nA	100nA
AC CURRENT			
Ranges	4 (200μA to 10A)	5 (200μA to 10A)	4 (200 μA to 10A)
Accuracy			
200μA to 20mA or 200mA	1.8% of reading + 4 digits, 50 Hz to 500 Hz	1.8% of reading + 4 digits, 50 Hz to 500 Hz	1.8% of reading + 4 digits, 50 Hz to 500 Hz
10A range	3.0% of reading + 4 digits, 50 Hz to 500 Hz	3.0% of reading + 4 digits, 50 Hz to 500 Hz	3.0% of reading + 4 digits, 50 Hz to 500 Hz
Overload Protection	0.8A/250V fuse	0.8A/250V fuse	0.8A/250V fuse
10A range only	Unfused	Unfused	Unfused
Voltage Burden	325mV	325mV	325mV
10A range only	700mV	700mV	700mV
Resolution	100nA	100nA	100nA
CAPACITANCE			
Ranges			5 (2nF to 20 μF)
Accuracy			3.0% of reading + 10 digits
RESISTANCE			
Ranges	6 (200 to 20MΩ)	6 (200 to 20MΩ)	6 (200 to 20MΩ)
Accuracy			
200Ω range (high power only)	1.2% of reading + 4 digits	1.0% of reading + 4 digits	1.0% of reading + 4 digits
2K thru 2MΩ	1.0% of reading + 2 digits	High: 0.8% of reading + 1 digit Low: 1.2% of reading + 2 digits	High: 0.8% of reading + 1 digit Low: 1.2% of reading + 2 digits
20MΩ range	2.5% of reading + 4 digits	High: 2% of reading + 4 digits Low: 3% of reading + 4 digits	High: 2% of reading + 4 digits Low: 3% of reading + 4 digits

SPECIFICATIONS (Continued)

	MODEL DM15	MODEL DM20	MODEL DM25
RESISTANCE (Cont.)			
Open Voltage (Max)			
200Ω range	3.2V	3.2V	3.2V
2K thru 20MΩ	1.5V	High 1.5V ; Low .3V	High 1.5V; Low .3V
Overload Protection	250V DC/AC	250V DC/AC	250V DC/AC
DIODE TEST			
Nominal Test Current	1mA	1mA	1mA
Open Voltage	3.2V	3.2V	3.2V
INSTANT CONTINUITY			
Open Voltage			3.2V
Overload Protection			250V DC/AC
Frequency			<3.5 kHz
Current draw			3mA
CONDUCTANCE			
2nS Range			
Resolution		1nS	
Accuracy		1.5% of reading + 2 digits	
200nS Range			
Resolution		0.1nS	0.1nS
Accuracy		3% of reading + 10 digits	3% of reading + 10 digits
Equivalent R Range	5MΩ to 10 000MΩ	5MΩ to 10 000MΩ	
TRANSISTOR HFE			
Test condition			
Base DC current		10μA	
Vce		2.8V	

Section Three
INSTALLATION

3.1 UNPACKING

Remove the multimeter from the container. The box should contain following items:

1. Multimeter.
2. Test lead set (one red, one black).
3. Operator's Manual.
4. 9-volt battery (located in battery compartment).
5. Two fuses (one installed and one spare).

3.2 BATTERY INSTALLATION

Unpack the battery, which was placed in the battery compartment, and connect the battery to the battery snap (see Paragraph 6.1, Battery Replacement).

CAUTION

Failure to turn off the instrument before installing the battery could result in damage to the instrument and battery if it is connected to the battery terminal incorrectly.

3.3 CLEANING CASE AND WINDOW

The front panel case should be cleaned with a mild solution of detergent and water. Apply sparingly with a soft cloth and allow to dry completely before using.

CAUTION

Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. These chemicals will react with plastics used in construction of case.

Section Four
FRONT PANEL DESCRIPTION

This section is designed to familiarize the user with the controls, indicators connectors, and other features of the multimeter. It is HIGHLY RECOMMENDED that the user become familiar with the controls, indicators, and connectors shown and described in Figure 1 before operating the device.

1. Digital Display
   Digital 3½-digit LCD readout (maximum reading 1999) with automatic polarity, decimal point, overrange, and low battery indicator.
2. Power Switch
   This switch is used to turn the instrument on and off.
3. Function/Range Switch
   This Function/Range Switch greatly simplifies the operation of the instrument. The one switch selects the function and the desired range.
4. COM Input Connector
   This connector is used as the common or low input for all measurements.
5. V-Ω Input Connector
   This connector is used as the high input for all voltage and resistance measurements as well as for conductance measurements (DM20 and DM25).
6. 10A Input Connector
   This connector is used for continuous current measurements from zero to 10A. Measurements between 10A and 20A for a duration of thirty seconds maximum may also be made using this terminal. Inputs beyond this maximum may cause damage to the instrument.
7. Transistor Input Connectors (Model DM20)
   For NPN or PNP transistors: Observe pin jacks for emitter, base, and collector.
8. Capacitor Input Connectors (Model DM25)
   Used to check capacitor capacitance value.
9. HI/LO Power Ohms Switch (DM20 and DM25)
   The LO position is for in-circuit measurements supplying a voltage below that necessary to cause conduction in a silicon junction, while the HI position is for out-of-circuit measurements.

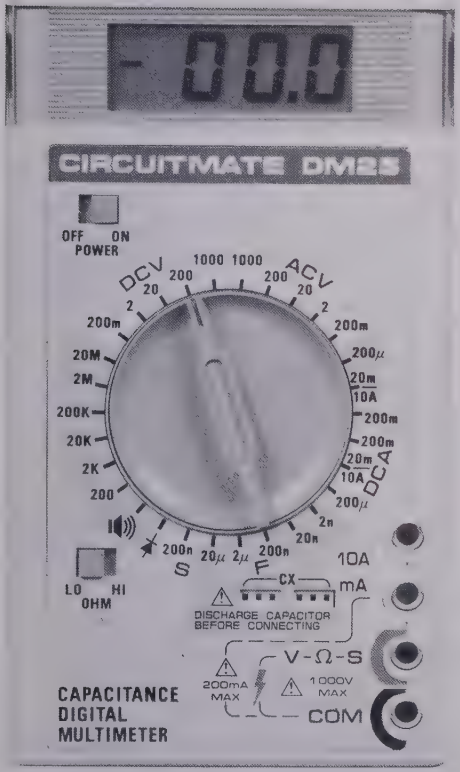

-00.0
CIRCUITMATE DM2S
OFF ON
POWER
DCV
ACV
1000 1000
200
20
2
200m
20M
2M
200K
20K
2K
200
200µ
20m
10A
DCA
2n
20n
200n
20µ
2µ
S
F
CX
10A
mA
LO HI
OHM
DISCHARGE CAPACITOR
BEFORE CONNECTING
V-Ω-S
200mA
MAX
1000V
MAX
COM
CAPACITANCE
DIGITAL
MULTIMETER

Figure 1.

Section Five
OPERATION

5.1 WARNINGS

1. Pay extreme caution when working near high-voltage sources. This includes any voltage measurements requiring the use of 200V AC, 750V AC, 200V DC, and 1000V DC ranges.
2. To avoid electrical shock hazard and/or damage to the instrument, do not measure voltages that might exceed 1000 volts above earth ground.
3. Using the A-input connector during current measurements, operator injury or damage to the instrument may occur if the fuse blows in a circuit which exhibits an open-circuit voltage greater than 250 volts.
4. Each time before using the instrument, inspect test leads, connectors, and prods for cracks or breaks in the insulation. If any defects are found, replace item immediately.
5. To avoid electrical shock hazard, do not touch test lead tips, or the circuit being tested, while power is applied to the circuit being measured.

5.2 SAFETY PRECAUTIONS

1. Exceeding the maximum input overload limits can damage the multimeter.
2. When making *current* measurements, make sure that the multimeter is connected in series with the load in which the current is to be measured; NEVER connect the multimeter ACROSS a voltage source. If this is done, it may either blow the overload protection fuse or damage the device being tested.

5.3 GENERAL FUNCTIONAL CHECK

Before placing the multimeter into use, a simple checkout procedure will ensure that the device is working properly.

1. Connect the red test lead to the V-Ω input connector and the black test lead to the COM input connector. Touch the red test lead and black test lead together.

2. Place the Function/Range Switch in sequence in the DC 1000V, 200V, 20V, 2V and 200mV positions. Observe the digital display, it should read 000 ±1 in each position.
3. Turn the Function/Range Switch in sequence to the 20MΩ, 2MΩ, 200kΩ, 20kΩ, 2kΩ, and 200Ω positions. With the two test lead tips separated, the digital display should read 1 (overrange). Touch the test lead tips together and observe the digital display; it should read 000 or 001 in each position. In the 200Ω position, the digital display may read 001 to 004, because of test lead resistance.

5.4 DC VOLTAGE MEASUREMENT

1. Connect red test lead to V-Ω input connector and black test lead to COM input connector.
2. Set Function/Range Switch to desired DCV position. If magnitude of voltage is not known, set switch to the highest range and reduce until a satisfactory reading is obtained.
3. Turn off power to the device or circuit being tested and discharge all capacitors.
4. Connect test leads to the device or circuit being measured.
5. Turn on power to the device or circuit being measured. Voltage value will appear on the digital display along with the voltage polarity.
6. Turn off power to the device or circuit being tested and discharge all capacitors prior to disconnecting test leads.

5.5 AC VOLTAGE MEASUREMENTS

1. Connect red test lead to V-Ω input connector and black test lead to COM input connector.
2. Set Function/Range Switch to desired ACV position. If the magnitude of voltage is not known, set switch to highest range and reduce until a satisfactory reading is obtained.
3. Turn off power to the device or circuit being tested and discharge all capacitors.
4. Connect the test leads to device or circuit being measured.
5. Turn on power to the device or circuit being measured. Voltage value will appear on digital display.
6. Turn off power to the device or circuit being tested and discharge all capacitors prior to disconnecting test leads.

5.6 DC CURRENT MEASUREMENT

1. Connect red test lead to the mA input connector for current measurements up to 200mA. For current measurements between 200mA and 10A, connect red lead to the 10A input connector. Connect black lead to the COM input connector.
2. Set Function/Range Switch to desired DCA position. If magnitude of current is not known, set switch to highest range and reduce until satisfactory reading is obtained.
3. Turn off power to the device or circuit being tested and discharge all capacitors.
4. Open the circuit in which current is to be measured. Now securely connect test leads in series with the load in which current is to be measured.
5. Turn on power to the circuit being tested.
6. Read current value on digital display.
7. Turn off all power to the circuit being tested and discharge all capacitors.
8. Disconnect test leads from circuit and reconnect circuit that was being tested.

5.7 AC CURRENT MEASUREMENTS

1. Connect red test lead to the mA input connector for current measurements up to 200mA. For current measurements between 200mA and 10A, connect red lead to the 10A input connector. Connect black lead to the COM input connector.
2. Set Function/Range Switch to desired ACA position. If magnitude of current is not known, set switch to highest range and reduce until satisfactory reading is obtained.
3. Turn off power to the device or circuit being tested and discharge all capacitors.
4. Open circuit in which current is to be measured. Now securely connect test leads in series with the load in which current is to be measured.
5. Turn on power to the circuit being tested.
6. Read current value on digital display.
7. Turn off all power to the circuit being tested and discharge all capacitors.
8. Disconnect test leads from circuit and reconnect circuit that was being tested.

5.8 RESISTANCE MEASUREMENTS

On the DM15, all resistance ranges are high-power ohms.

On the DM20 and DM25, the resistance ranges depend on the position of the OHM Switch. In HI position, all resistance ranges are high-power ohms. In LO position,all ranges *except* the 200-ohm range are low-power ohms. Use LO position for accurate measurements of in-circuit resistance; use HI position for out-of-circuit measurements.

1. Connect red test lead to the V-Ω input connector and black test lead to the COM input connector.
2. Set Function/Range Switch to desired Ω position. If magnitude of resistance is not known, set switch to highest range and reduce until satisfactory reading is obtained.
3. If the resistance being measured is connected to a circuit, turn off power to the circuit being tested and discharge all capacitors.
4. Connect test leads to the circuit being measured. When measuring high resistance, be sure not to contact adjacent points, even if insulated, because some insulators have a relatively low insulation resistance, causing the measured resistance to be lower than the presumed resistance.
5. Read resistance value on digital display. If a high resistance value is shunted by a large value of capacitance, allow digital display to stabilize.

5.9 DIODE AND TRANSISTOR TEST MEASUREMENTS

The special Diode Test Function allows measurements of forward voltage drops across diodes and transistor junctions. This function also permits measurement of in-circuit semiconductor junctions.

5.9.1 DIODE TESTS

1. Connect red test lead to the V-Ω input connector and black test lead to the COM input conector.
   - Set Function/Range Switch to the diode test (⊣◀) position.
   - If the semiconductor junction being measured is connected to a circuit, turn off power to circuit being tested and discharge all capacitors.
   - Connect test leads to the device.
   - Read forward voltage drop on digital display. Normally the value of a good silicon type diode is 0.600 to 0.900; if 0.605 is displayed, the approximate forward voltage is 605mV.

2. If the digital display reads (1) overrange, reverse the lead connections. The placement of the test leads when the forward voltage is displayed indicates the orientation of the diode. The red lead is then connected to the anode and black lead is connected to the cathode as shown in Figure 2. If (1) overrange is displayed with both lead connections, the junction is open. If a low reading (less than 1.000) is obtained with both lead connections, the junction is shorted internally or (if the junction is measured in a circuit) the junction is shunted by a resistance less than 1kΩ. In the latter case, the junction must be disconnected from the circuit in order to verify its operation.

5.9.2 TRANSISTOR JUNCTION TESTS

Transistors can be tested in the same manner as diodes by checking the two diode junctions formed between the base and emitter and the base and collector of the transistor. Measurement between the collector and emitter also should be made to determine if a short is present.

5.10 CONTINUITY CHECKS (Model DM25 Only)

This continuity check is particularly useful in circuit and cable tracing.

1. Set Function/Range Switch to the continuity check position ( ).
2. Connect red test lead to the V-A-Ω input connector and black test lead to the COM input connector.
3. Place one test lead probe at one end of cable or circuit to be tested. Use the other test lead to trace the cable or circuit until the circuit is complete. When continuity is established a built-in buzzer will sound. If contact in the cable or circuit is maintained long enough, the resistance value of the cable or circuit will appear in the display.

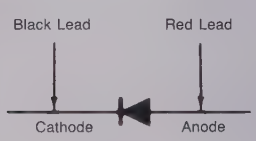


Figure 2.

5.11 TRANSISTOR HFE MEASUREMENTS (Model DM20)

1. Set Function/Range Switch to HFE position.
2. Insert transistor leads into HFE socket for transistor type (NPN or PNP), observing emitter (E), base (B), and collector (C) positions.
3. The displayed value is the transistor HFE value (the transistor beta, or current gain, from the input to the output of the device).

   Test Condition: Base DC current, 10μA (approximate)
   Vce 2.8V (approximate).

5.12 CAPACITANCE MEASUREMENTS (Model DM25)

1. Set the Function/Range Switch to the capacitance function and the highest range.
2. Discharge the capacitor to be tested.
3. Insert capacitor leads into the two test jacks.
4. Read capacitance on display.
5. Reduce range setting until a satisfactory reading is obtained.
6. Remove capacitor, taking care not to touch leads.
7. Discharge capacitor.

Section Six
SERVICING INSTRUCTIONS

WARNING

To prevent electrical shock hazard, turn off multimeter and disconnect test leads before removing battery cover or back cover.

6.1 BATTERY REPLACEMENT

1. After disconnecting test leads and turning off multimeter, press battery cover and push away from meter to open.
2. The battery is located in the battery compartment as shown in Figure 3.
3. Disconnect battery from instrument and replace with a standard 9-volt transistor battery and replace battery cover.

CAUTION

Failure to turn off the instrument before installing the battery could result in damage to the instrument and battery if it is connected to the battery terminal incorrectly.

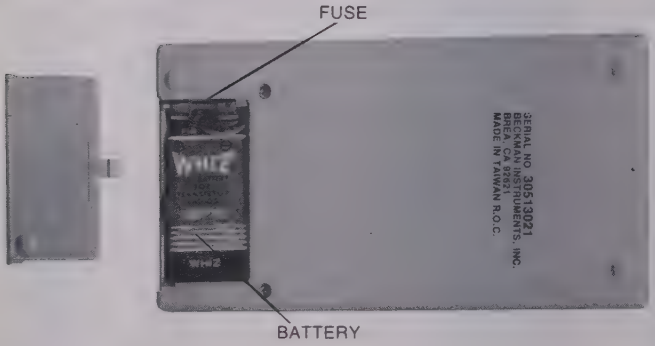


Figure 3.

6.2 FUSE REPLACEMENT

1. Remove battery cover. Remove old fuse and replace with spare fuse. Replace battery cover.

WARNING

To prevent fire, use 0.8A/250V fuse only.

6.3 CALIBRATION

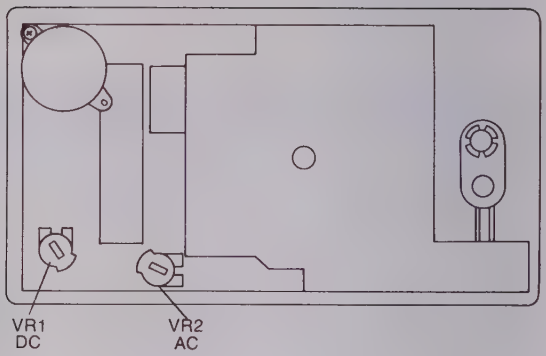
In order to maintain the specifications described in Section 2 of this manual, it is recommended that the multimeter be calibrated once each year. The equipment required for calibration is as follows.

Instrument Type	Required Characteristics	Recommended Models
DC/AC calibrator	Voltage range: 0 to 1000V DC/AC Accuracy: ±0.01%	Rotek 3920 or Equivalent

Use the following procedures to calibrate the multimeter:

1. Perform calibration at an ambient temperature of 23°C ± 2°C and a relative humidity of 80% or less.
   Allow instrument to stabilize at this temperature for at least thirty minutes.
2. Remove the back cover from the instrument by removing two screws and then lifing off cover.
3. Set the output of the calibrator for DC 190mV and connect it to the V-Ω and COM input connectors.
4. Turn the Function/Range Switch on the multimeter to the 200mV DC position.
5. Using a small flat-tipped screwdriver, adjust potentiometer VR1, as identified in Figure 4, until multimeter digital display reads 190.0 or 190.1.
6. Set the output of the calibrator for AC 190mV 400 Hz.
7. Turn the Function/Range Switch on multimeter to the 200mV ACV position.
8. Adjust potentiometer VR2 until multimeter digital display reads 189.9 to 190.1.
9. Disconnect calibrator from multimeter.
10. Replace back cover and secure with two screws.

DM25



DM15 AND 20

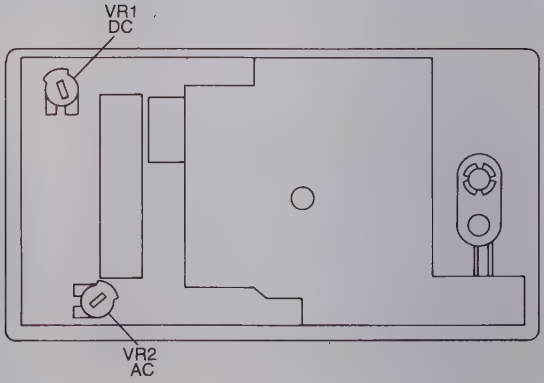


Figure 4.

6.4 PARTS LIST

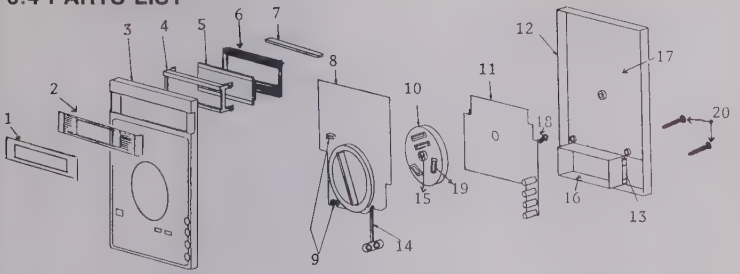


Figure 5. Multimeter Assembly

CircuitMate DM15, DM20, and DM25 Multimeter Assembly

Item No.	Ref. Des.	Beckman Part No.	Description	Qty.
1.		FG3002-920-235	Window Mask	1
2.		FG3002-420-243	Window Cover	1
3.		FG3002-574-100	Front Case Assy-DM15	1
		FG3002-574-101	Front Case Assy-DM20	1
		FG3002-574-102	Front Case Assy-DM25	1
4.		FG3002-420-246	LCD Holder	1
5.		FG3002-390-105	LCD	1
6.		FG3002-420-245	Cover-LCD	1
7.		FG3002-370-267	Elastomeric Connector	2
8.		FG3002-560-101	Large Bd. Assembled-DM15	1
		FG3002-560-100	Large Bd. Assembled-DM20	1
		FG3002-560-102	Large Bd. Assembled-DM25	1
9.		FG3002-420-244	Power/Ohm Switch Knobs	2
10.		FG3002-420-249	Wheel Rotary Plastic	1
11.		FG3002-520-105	Small Bd. Assembled-DM15	1
		FG3002-520-101	Small Bd. Assembled-DM20	1
		FG3002-420-103	Small Bd. Assembled-DM25	1
12.		FG3002-574-105	Back Case Assembly	1
13.		FG3002-400-119	Fuse-800mA 250V	1
14.		FG3002-371-105	Battery Connector	1

(continued next page)

Item No.	Ref. Des.	Beckman Part No.	Description	Qty.
15.		FG3002-450-254	Rotary Spring	1
16.		FG3002-420-250	Battery Plastic Cover	1
17.		FG3002-450-256	Shield	1
*18.		FG3002-450-251	Screws-M2x8mm	4
19.		FG3002-450-255	Contact Spring	8
*20.		FG3002-450-258	Screws-M2.3x10mm	2

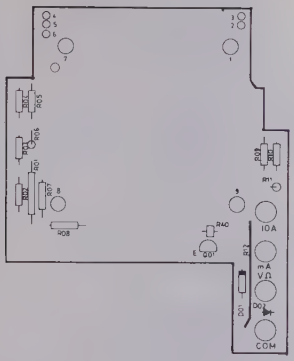
6.4.1 PARTS LIST

CircuitMate DM15, DM20, and DM25 Circuit Board Component Parts

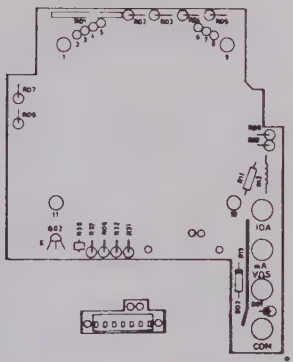
Item No.	Ref. Des.	Beckman Part No.	Description	Qty.
		Small Board Component Parts		
	R01	FG3002-040-123	Res. 8.98M .5%	1
	R02	FG3002-050-214	Res. 898k,.5%,1/4W	1
	R03	FG3002-050-213	Res. 89.8k,.5%,1/4W	1
	R04	FG3002-050-212	Res. 8.98k,.5%,1/4W	1
	R05	FG3002-050-206	Res. 898,.5%,1/4W	1
	R07,R08	FG3002-030-563	Res. 56k,.5%,1/2W	2
	*R09	FG3002-050-207	Res. 900,.5%,1/4W	1
	R10	FG3002-050-202	Res. 90,.5%,1/4W	1
	R06	FG3002-050-203	Res. 99.8,.5%,1/2W	1
	R11	FG3002-050-201	Res. 9,.5%,1/4W	1
	R12	FG3002-070-105	Res. WW .99,.5%	1
	R13	FG3002-040-101	Res. WW .01,1.4%	1
	*R31,R32, R37	FG3002-010-224	Res. 220K,5% 1/4W	3
	R36	FG3002-080-104	PTC 1k 40%,245 Vrms	1
	Q02	FG3002-250-108	Trans. NPN S1,2SC1959	1
	*D01,D02	FG3002-230-107	Diode 1N4001	2
	S1,S2	FG3002-400-120	Power/Ohm Switch	2

*Part commonly available from local commercial sources of electronic supplies, and *not* available from Beckman Instruments.

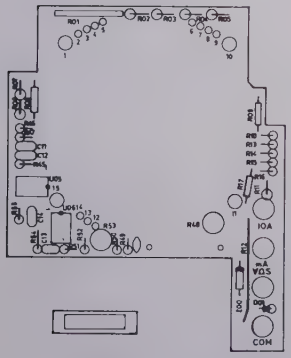
Parts listed *without* asterisk notation (*) are available through Beckman's Customer Service Department.



DM15



DM20



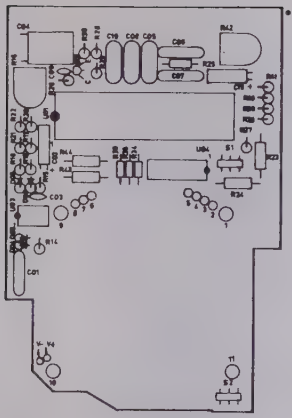
DM25

Figure 6. Small Components Locator for DM15, DM20, and DM25

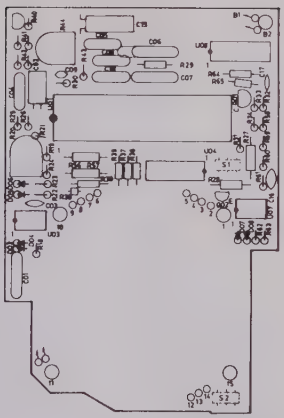
Item No.	Ref Des.	Beckman Part No.	Description	Qty.
		Large Board Component Parts		
	*C02,C05, C08,C10	FG3002-130-114	Cap Met. Mylar .luf 10% 100V	4
	*C01	FG3002-130-101	Cap, .022uf,10%,630V	1
	*C02	FG3002-160-101	Cap, 22 uf,20%,16V	1
	*C03	FG3002-100-101	Cap, 33 pf,5%,50V	1
	*C06,C07	FG3002-130-102	Cap, .22 uf,10%,100V	2
	*C09	FG3002-100-105	Cap, 100 pf,5%,50V	1
	*C15	FG3002-160-100	Cap, 10 uf,20%,16V	1
	*D03,D04, D05,D06	FG3002-200-100	Diode 1N4148	4
	Q01	FG3002-250-107	Trans. NPN,S1,2N3904	1
	*R14	FG3002-010-103	Res. 10K,5%,1/4W	1
	*R15	FG3002-101-225	Res. 2.2M,5%,1/4W	1
	R16,R42	FG3002-090-120	Res. Var. Trim 200/20 Tp Adj.	2
	*R23,R24, *R43,R44	FG3002-030-564	Res. 560k,5%,1/2W	4
	R17	FG3002-050-209	Res. 4.99k,1%,1/4W	1
	R18,R19	FG3002-050-210	Res. 5.62k,1%,1/4W	2
	*R20	FG3002-010-204	Res. 200k,.5%,1/4W	1
	*R21	FG3002-010-562	Res. 5.6k,5%,1/4W	1
	*R22	FG3002-010-394	Res. 390k,5%,1/4w	1
	*R27,R28	FG3002-010-224	Res. 220k,5%,1/4W	2
	*R29,R30, *R33,R34, R35	FG3002-010-105	Res. 1M,5%,1/4W	5
	*R25,R26	FG3002-010-114	Res. 110k,5%,1/4W	2
	R38	FG3002-050-211	Res. 8.06k,1%,1/4W	1
	R39	FG3002-050-208	Res. 4.75k,1%,1/4W	1
	R40	FG3002-050-205	Res. 472,1%,1/4W	1
	R41	FG3002-050-204	Res. 453,1%,1/4W,Fac.Sel.	1
	U01	FG3002-270-120	IC C-MOS 7160PL	1
	U03	FG3002-270-119	IC LTLM358P	1
	U04	FG3002-270-106	IC C-MOS 4070BE	1

*Part commonly available from local commercial sources of electronic supplies, and *not* available from Beckman Instruments.

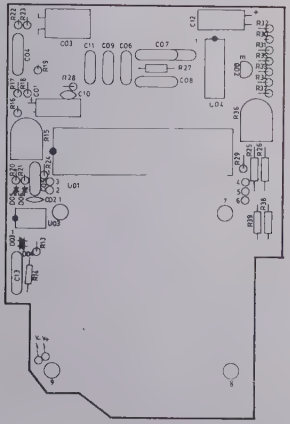
Parts listed *without* asterisk notation (*) are available through Beckman's Customer Service Department.



DM15



DM20



DM25

Figure 7. Large Components Locator for DM15, DM20, and DM25.

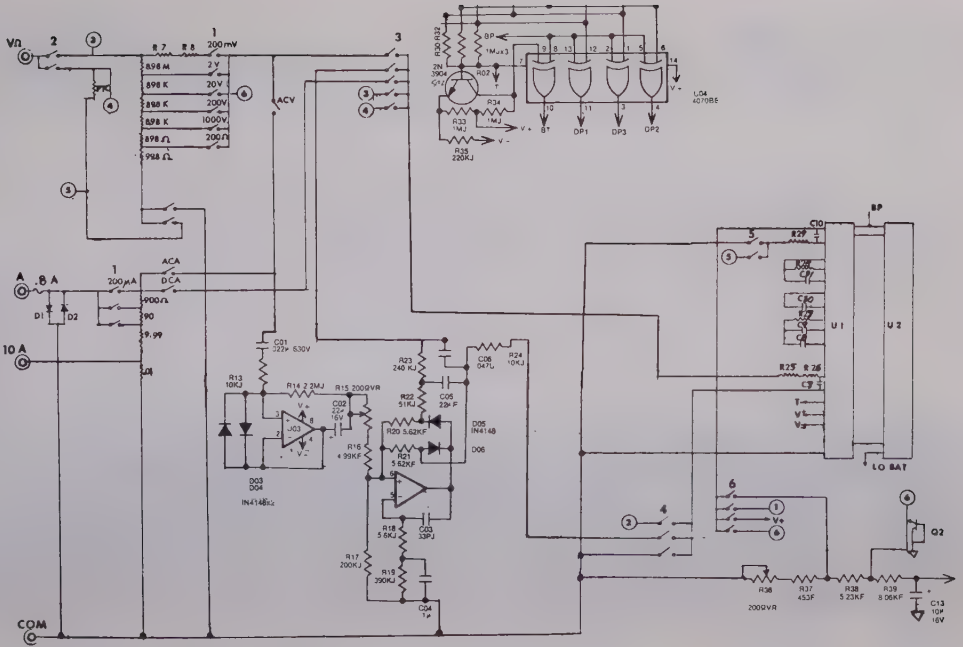


Figure 8. Schematic Wiring Diagram of DM15

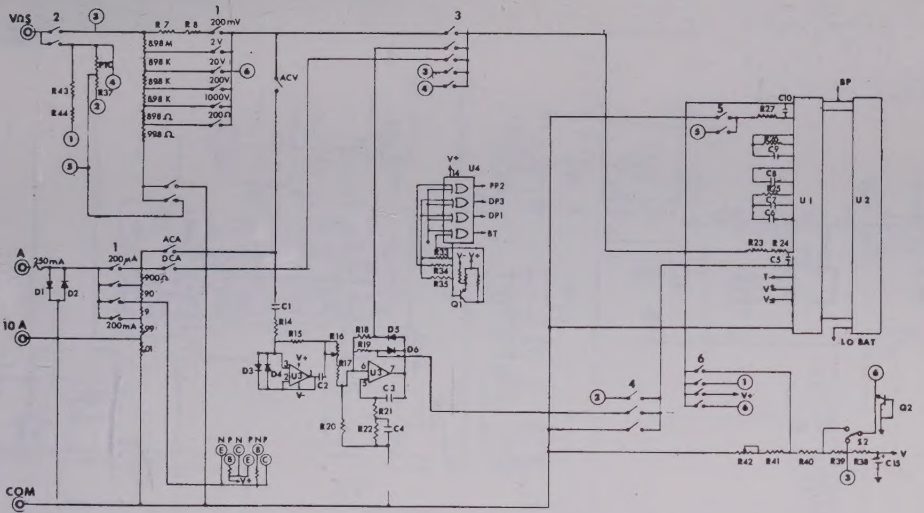


Figure 9. Schematic Wiring Diagram of DM20

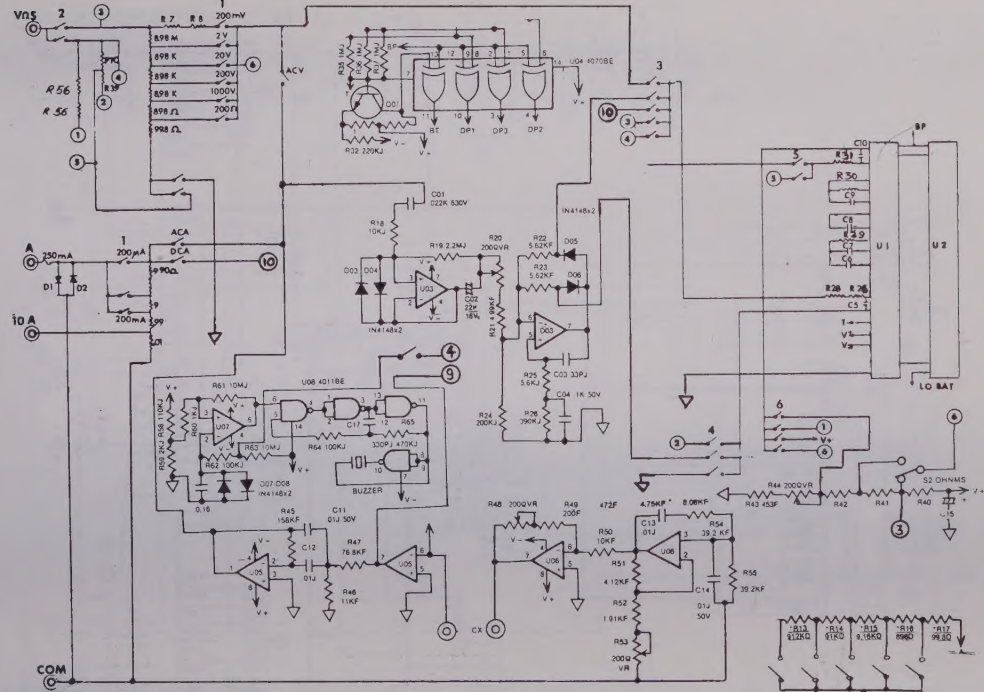
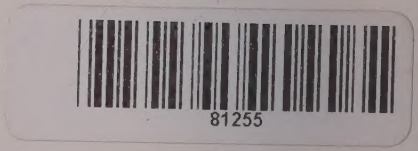


Figure 10. Schematic Wiring Diagram of DM25



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